CPT for Improving the Representation of the Stratocumulus to Cumulus Transition in Climate Models

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In 2007 the IPCC reiterated that *clouds remain the largest source of uncertainty* in climate projections. In this context, boundary layer clouds, and in particular the transition from stratocumulus to cumulus, play a key role in the cloud-climate feedback. These clouds are also important to the surface energy balance and the sea surface temperature distribution and are key elements in biases in seasonal coupled model forecasts and simulated mean climate.

Current climate and weather models are still far from realistically representing clouds. Improving the representation of clouds in climate models is fundamental to improving confidence in both seasonal and long-term climate projections. Both the NCAR and NCEP models have been recently upgrading their cloud, boundary layer, and shallow cumulus convection parameterizations. Several recent studies (e.g. the GCSS Pacific Cross Section Intercomparison and the Pre-VOCALS model intercomparison) have shown that these models are nevertheless not adequately simulating subtropical stratocumulus and the transition to cumulus.

The objectives of this proposal are to improve the representation of the stratocumulus-to-cumulus transition in the NCAR and NCEP climate models by (i) improving the interactions between existing model parameterizations by combining careful single-column modeling with sensitivity studies using weather-forecast mode and coupled-ocean global simulations, (ii) implementing probability density function (PDF) cloud parameterizations for boundary layer clouds, (iii) implementing a combined eddy-diffusivity and mass-flux vertical mixing parameterization; (iv) careful comparison with large-eddy simulations, all in conjunction with an international GCSS intercomparison effort on this transition.

Scientific merits of the proposed work include the development of more physically realistic parameterizations of boundary layer cloud and development of a better fundamental understanding of how the most important low-latitude boundary layer cloud transition depends on precipitation processes and feeds back on El Nino.

Its broader impacts include serving the US public and policy makers by improving climate projections (especially cloud feedbacks and biases) with the NCAR climate model, and improving weather and seasonal/El Nino forecasts with the NCEP model.